بسم الله الرحمن الرحيم

# An Assessment of the Nutritive Value of Some Browsing Trees Preferred by Camels in Southern Darfur

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## *DEDICATION*

*To my parents*

*For the uncompromising principles that guided their life*

*My sisters and friends*

*For making every thing wonderful*

*My teachers*

*For showing me the excitement and joy of science*

*With love and respect.*

*Kauther*

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*With my Best wishes to all*

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Animal production

## Abstract

This study was carried out on seven tree species highly desired by camels in South Darfur state near Nyala.

Proximate Analysis was carried out on twigs of *Acacia tortilis* (Seyal), *Acacia nilotica* (Sunt), *Balanites aegyptiaca* (Hagleeg), *Ziziphus spina-christi* (Sidir), *Combretum aculeatum* (Shehat),*Cadaba farinose* (serih) and *Buhinia rufescens* (Kulkul).

The results showed that Crude protein ranged between 11.37% and 16.23%, crude fiber between 27.94% and 34.64% , ether extract between 1.90% and 3.97%, ash between 4.51% and 8.37% and nitrogen free extract between 36.75% and 46.26% .

As Ca, P and Mg contents were 0.75%- 2.06%, 0.051% -0.50% and 0.19%- 0.40%, respectively.

The *in vitro* digestibility of dry matter ranged between 47.55% and 64.77%

In concluding the seven tree species are of high nutritional value to camel in south Darfur.

# تقييم القيمة الغذائية لبعض الأشجار المفضلة للإبل فى منطقة جنوب دارفور


## كوثر حامد على قجة

## إنتاج حيوانى


## الخـلاصــة


أجريت الدراسة علي سبعة أنواع من الأشجار المفضلة للابل في جنوب دارفور بالقرب من مدينة نيالا، أجري التحليل التقريبي لافرع كل من السيال (*Acacia tortils*) والسنط (*Acacia nilotica* والهجليج (*Balanites aegyptica* ) والسدر( *Ziziphus spina-christi* ) والشحيط ( *Combretum aculeatum* و السريح ( *Cadaba farinosa* ) و الكلكل *(Buhinia rufescns* ).

أظهرت النتائج أن والبروتين الخام تراوح بين11.37% و16.23 % والالياف الخام بين27.94% و34.64% والدهن بين 1.90% و3.97% والرماد بين 4.51% و8.37% و المستخلص الخالي من النيتروجين بين 36.75% و46.26% .

وبلغ محتوي الكالسيوم و الفسفور والماغنسيوم 0.75% -2.06% و0.05%-0.50% و0.19%-0.40% علي التوالي .

وتراوح هضم المادة الجافة معمليا بين 47.55% و64.77% ، خلصت هذه الدراسة أن أنواع الأشجار التى تمت دراستها ذات قيمة غذائية عالية للإبل فى جنوب دارفور .

# CHAPTER ONE

## INTRODUCTION

In recent years .Camels received good attention not only in the Sudan but Worldwide. This referred to the progressive Importance of these animals uniquely adapted to harsh Environmental Conditions especially in the arid and semi-areas in addition to their propagated role in the national income (Barakat *et al.*,2007).

Livestock production plays a major part in rural economy and social stability. It is the main supplier of high quality proteins, cash for families, draught power, satisfaction of religious and social festivals, and manure for the soil. In addition it is a way of living to people and their families (Harbi, 1992).

Sudan has the largest animal population in Africa, it became in the second rank for that purpose. The livestock population is estimated to be about (140.606)million heads of which, cattle (41.426), sheep (51.67), goats (43.104) and camels (4.406).(MOARF, 2008).

The Camel is an important animal in solving the crisis of food security in arid and semi-arid developing countries. The camel is a good source of meat and milk in areas where the climate adversely affects animals. Camel can provide high quality meat which is low in cholesterol and high in protein (FAO, 1982).

The feed resources available to the livestock include natural pastures, crop residues and agro-industrial by- products in that order of importance.

The nutritive value of pasture and range in the Sudan is greatly affected by seasonal changes. In the summer. (Dry period) the moisture

content, crude protein (CP) and total soluble sugars decreases and the plant tend to be of relatively poor nutritive value ( El hag, 1985).

Fodder trees and shrubs constitute a vital component in livestock productivity in the arid and semi-arid zones where about 52% of the cattle, 57% of the sheep, 65% of the goats and 100% of the camels in tropical Africa are found (Von Kaufmann, 1986). They supply goats and camels with the bulk of their nutritive requirements and complement the diet of cattle and sheep with protein, vitamins and minerals in which bush straw is deficient during the dry season. Nutrition of game animals also greatly depends on them. To people, they serve useful purposes such as the provision of food, drugs, fire wood and building materials.

The objectives of this study were-

1- To identify some of the important browse plant species consumed by camels in south Darfur.
2- To assess the chemical composition of the trees.

# CHAPTER-TWO

# LITERATURE REVIE

## 2.1 .Natural pasture:

Within the zone of semi-arid and high rainfall woodland savannah, pasture is the principal feed resource for ruminants (Harrison, 1955).

El Hag (1985) reported that the decrease in yield of pasture and range in the Sudan was attributed to many factors which include fires, nomadic over-grazing of a lot of natural pastures and range areas, unplanned expansion in crop production at the expense of pasture and range, successive drought which resulted in soil erosion and desertification in many pastoral areas. Further more, the nutritive value of pasture and range in the Sudan was greatly affected by seasonal changes. In summer. Dry period the moisture content, crude protein and total soluble sugars decrease and the plants tend to be fibrous with a high ash content and relatively low nutritive value.

Elginaid (1997). And Toutain (1980). Showed that the grasses provide sufficient feed supplies from July to December. Utilization on the other hand, at the time when grazing offers animal low quality dry grasses, browse species constitute the real feed resources. They are intensively utilized by livestock. Le Hourou (1980). Reported that from strictly pastoral point of view, and with no supplementation being given, browse should represent at least 20% of feed for livestock.

## 2. 2. Importance of the browse species:

Browse trees are important in ruminant feeding systems. They have been reported to be more nutritious than most grasses and herbaceous legumes and conserve their nutrients into the dry season when feed resources are depleted (FAO, 1997).

Leaves of fodder trees of some species may have a potential for providing supplemental nitrogen and energy to animals in the dry season. The current knowledge. However, is still limited on the changes in nutritive value of leaves in the dry season.

The main features of browse plants are their high crude protein (CP) and mineral contents. The concentration of CP in the leaves and fruits of the majority of fodder trees and shrubs is above 10% even in the dry season when it tends to decrease. Generally, calcium and potassium contents are higher than those of other minerals. The role of trees and shrubs in the supply of vitamins is indirectly demonstrated in dry tropical Africa by the fact that browsers such as goats and camels seldom contract photophobia or eye inflammation which many cattle are prone to it during the dry season. Some acacia species including *Acacia brevispica, Acacia nubica, Acacia tortilis, Acacia seyal, Acacia nilotica* and *Acacia mellifera* have been shown to contain appreciable crude protein (134-213gkg$^{-1}$DM) and minerals (Abdulrazak ,*et al* 2000).

**2.2.1. Macro - mineral of browse:**

Plant materials provide the source of mineral nutrient to grazing ruminants. The mineral composition of plants varies according to many factors, among those are the age of the plant, the soil, differences among the species and varieties and climatic or seasonal conditions (Conard,1978). In contrast minerals and vitamins content are very important in browse trees and shrubs (Toutain,1980).

Green plants are an excellent dietary source of Mg for animals because of the presence of Mg in chlorophyll. Mg in the diets of ruminants, browse plant had higher level of Mg than forages. (Shamat, 2009).

## 2.3:The Important browse trees in the study

In western Sudan, the natural vegetation is a function of rainfall and soil types. The northern areas are semi-desert where the natural vegetation consists of herbs, annual and perennial grasses and scattered bushes and trees. The vegetation of the low rainfall wood land and savannah is composed of grasses and greater number of trees than in semi-desert. The vegetation changes as one move southwards, where rainfall is comparatively high and the percentage of clay areas increases. Although the vegetation of the moist sandy area is richer, the vegetation of the clay areas is predominated by *Acacia mellifera, Acacia seyal, Balanites aegyptiaca* and grasses (El khalifa *et al.*, 1985).

In southern Darfur, the natural pasture is classified into three main regions according to the natural use (Babiker *et al.,* 1999). The first region is the northern region which is located between lat. 11º - 13º N in the semi arid. The rainfall in this region ranges between 200 and 300 mm. This region is considered to be a good pasture in the rainy season (autumn habitats/Makharif). The second region is the middle region which is located in sandy soil between 10º - 11º N in the low land savanna area. The rainfall in this region ranges between 300 and 600 mm. This region is also considered as autumn habitat (Makharif). The third region is the southern region, which is located in the wood savannah between 8º - 10º N, and which is characterized by its clay soil. The rainfall in this region ranges between 600 and 1000 mm. This region is characterized by a pasture rich in

grasses and trees such as *Acacia seyal , Bauhinia rufescens* and *Balanitis aegyptiaca.* This region is considered as a traditional summer habitats (Masaif).

In southern Darfur there are many trees that provide fodders to livestock specialty in dry season. Camels especially in this region depend mainly on these trees. There are many tree families that provide fodders to camels which include; *Mimosaceae, Capparidaceae, Balnitaceae ,Rhamnaceae* and *Combretaceae*. These tree families provide leaves, pods flowers to livestock . The important tree families of which area .

**2.4. *Family Mimosaceae*:**

Trees or shrubs (in ours).Leaves alternate, 2.pinnate modified to phyllodes which look like simple leaves. Inflorescence usually spikes, racemes or heads of small , actinomorphic (3-)5(-6). Merou flowers. Sepals usually united to form acaly x .petals valvate in bud, free stamens 4-10, as many as. Pods and seeds various. Seeds generally marked with and areole (coates, 2002 ).

**2.4.1. *Acacia tortilis***

Local name Seyal

A tree, usually with a after or very broadly spreading crown , the bark color grey to black , rough and fissured ,spines of two types , some short and hooked straight and whitish,leaves, bipinnate, pinnae 2-10 pairs, inflorescence a spherical head of many tiny cream or white flowers, pod thin – textured, contorted, often into a spiral, seed brownish (IPBPGR ,1984). The tree flowers between January to May (El Amin, 1990). The leaves, young branches and , particularly the fallen fruit are eaten by all species of wild and domestic animals, and it can be, when feed resources

are scares and mostly low in nitrogen, Avery important component of the diet in many parts of arid and semi –arid Africa (IBPGR ,1984 ).

Fadel Elseed (1999 ).indicated that the range DM, CP, CF, EE and NFE.( 42.20- 45.21), (16-25 ), (15-20 ), (2.77-6.17 ) and (52.05- 52.26 ).while that the range of the Ca, Mg and P. respectively .(1.41-2.80), 90.26- 0.46 ) and ( 0.14-0.18 )%

**2.4 .2: *Acacia nilotica***

*Acacia nitotica* in the Sudan. Flowers irregularly but usually in the period June to September. With seeding occurring from January to May. Extensive leaf fall occurs in April May with re-foliation in March –April. Leaf production and fall is similarly influenced by rainfall, whereas temperature affects flowering and fruiting ( khan, 1970).

It is commonly browsed when there is an absence of green feed. The protein content of early green Mitchell grass leaf may be as high as 18%. But this rapidly declines and by the end of the season .ranges from 2.5 to 4.5% which is insufficient to maintain animal productivity.

Browse and pod fall (November to February) can be an important supplement for animals grazing the low quality Mitchell little pod set away from permanent water.

Carter (1990 ) indicated that the CP, EE, NFE, ADF, NDF and Ash of *acacia nilotica* leaf were ,13.92, 6.63, 60.99, 10.35, 20.38 and 9.29 % respectively and that P , Ca and Mg of same plant leaf were 0.23 , 2.53 and o.18 %.

**2 .5: *Family : Blanitaceae***

Small trees or shrubs with simple or forked spines. leaves alternate bifoliolate, petiolate or sessile; leaf late coriaeous or subsucculent, entire; flowers hermaphrodit, actinomorphic, fragrant; sepals stree glabrous or

hairy; stamens 10; anthers 2-locular; filament free filiform, disck succulent; conical or invertedly cup- shaped or copular, surrounding the ovary; ovary superior, subglobose, 5- locular with 1-pendulous ovule in each loculus. Fruit 1-2 seeded of drupes; endocarp often woody (Gibreel,20080).

**2.5- 1: *Balnites aegyptiaca***

Local name : Hagleeg

Tree 8-10m high crown spreading usually with dense drooping vertical green branchlets . leaves bifoliate , with leaflets of ovate to ovate – lanceolate or rhomboid blade shape. prickles in pair greenish , with yellowish wers. Flowers are yellow –green, spura-axillary clusters. Fruits are drupes oblong – elliptic, egg shaped green in colour turning yellow or brown when ripped. Flower November–April; and fruits. December-July (Gibreel, 2008).

**2.5-1-1:Habitat and distribution:**

Very common on dark cracking clay of central Sudan often associated with *acacia seyal* on short grass savanna (El Amin,1990).

**2.5-1-2: Uses:**

Wood is pale yellow, coarse grained, hard, is used as local furniturc, joinery, walking sticks, bend. The fruits are eaten by men and animals. The inner core of the seed is crushed to provide oil for cooking. The pulp contains 40% sugar. Sapnin also occurs in roots, bark, wood chips and fruits hence their use in washing clothes. Animals eat the foliage. It is also a good shade tree in the hot savanna (El amin ,1990) .

As far as the chemical composition of the tree. Fadel Elseed (1999) reported that the DM, CP, CF, EE and NFE Respectively.(43.66-47.54), (20-22 ), (19- 20), (3.54- 3.98) and (44.42 – 45.57)% and that Ca , P and Mg Respectively . ( 1,42- 2.73 ), (0.08-0.13) ( 0.39 – 0.52 ) and .

**2.6:** ***Family Capparidaceae***

Trees. Shrubs or climbing herbs. Leaves usually alternate, or digitally 3-7 folilate , stipules where present minute and spiny . inflorescence variable axillary or terminal; flower usually hermaphrodit actinomorphic, hypogynous; sepals free united; imbricate or valuate usually 4; petals 4 many, free or absent, stamens free many, free or attached to agynophore; anthers 2-locular, longitudinally dehiscent; ovary superior sessile or carried on long or short gynophores, 1- locular with parietal placentation or divided into 2 or more loculi, ovules free- many. Fruits capsules or berries are winged and indehiscent, sometimes elongate or torulose, seeds reniform or angular (Gibreel,2008) .

**2.6.*1: Cadaba farinose:***

Densely branched shrubs or small trees up to 5m high –brak glands or glandular hairy rack smooth, sometimes obviate oblong. 0.5-5x 0.3-3cm, farinaceous ; petioles up to 3mm long . inflorescence few- flowered ,shortly subcerymbose racemes ; pedicels 5-15mm long; outer sepals (2), concave, a cute and apiculate,5-14 mm long, covered with sessile scales or stalke glands or glandular hairy, inner sepals (2) much more obtuse and flatter ; petals 4, creamy yellow blade narrowly lanceolate – elliptic , long – clawed ' 10 -13 mm long; androphore 5-8mm longs, 4-5, filaments 1-2cm long, glabrous, gynophores scales. fruit slightly torulos up to 5cm long, 7mm a cross, usually densely puberulent; seeds covered by bright orange membrane. flowers Nov- July; fruit Nov- Feb (El amin, 1990).

**2.6.1-1:Habitat and distribution:**

Dry short grass savanna in Red Sea Hills (J.Elba), kassala, Khartoum, Blue Nile ( wad Medani ); white Nile, Kardfan ( El obeid ) Darfur (El faher) and S.E Equatoria (El Amin, 1990).

**2.5.1-2:Uses:**

The wood can be used as fire wood and building material .the leaves are suitable as fodder and medicinal purposes. The global grazing habit of a large number of domestic ruminants has a detrimental effect on the environment, especially as the stocking density can be very high in marginal grazing areas. The high stocking density and fewer water points in these zones, erosion due to constant trampling around water points can be added to detrimental effect of overgrazing. The available literature on vegetation of the Sudan is essentially that of Andrews (1956), Harrison and Jackson (1958).

**2.6.1-3:Nutritive value:**

Generally, Calcium and Potassium content are higher than those of other minerals (Backlund and Belskog, 1991). Browsers can consume various parts of woody plants: leaves, twigs, thorns, bark, wood, bulbs, tubers, roots, flowers, seed, pods and fruits (Le Houerou, 1980). Minson (1982) indicated that low protein levels characteristic of tropical forages during the long dry season are the limiting factors in animal intake and performance. To worsen the ecology and its available feed resources, further, there is widespread annual burning of native grasslands, thereby drastically reducing the amount of forage on offer. Indeed, it has been observed that a combination of these factors- low quality roughages and bush burning.

2.7: ***Family***: ***Caesalpiniaceae*** :

*Caesalpima* where it is anomocytic. The development of an anomocytic stoma is perigenous, but those with subsidiary cells are largely mesogenous; rarely paracytic stomata are mesoperigenous. In spite of diversity of stomata, different types of stomata have similar patterns of development in different

organs of the same plant. The present investigation also indicates that the inconstancy of stomata in the family is due to (*a*) their diversity and (*b*) an increase in the number of subsidiary cells either by their division or by the neighbouring perigenes becoming subsidiary cell-like.( Shah *et al*, 1970 )

**2.7-1*: Bauhinia rufescens* :**

Small trees or shrubs up to 8m high. Bark grey. Smooth with transversely elongated lenticels. Branchlets often armed with pointed short lateral shoots .leaves bilobed almost to the base, about 2cm long; lobes semi- circular. Inflorecence terminal racemes ; flowers white cream, small, fragrant; sepals spathaceous, pubescent; petals spathulate; white; stamens 10, filaments hairy at base. fruit persistent on long stipes, linear, curved. obliquely constricted, coriaceous, brown-black, 6-9x2cm, seeds brown, shiny, 7x5mm. flowers Jan-April, fruits April- August (El Amin, 1990).

**2.7-1-1:Habitat and distribution:**

In the savanna zones of south kordofan, Darfur and south Sudan (El amin,1990) .

**2.7-1-2: Uses:**

In Ghana, farmers, hunters and field workers eat the wild fruits. Fodder: The green and dried fruit and the leaves and shoots are valuable forage, favored by many species of wild and domestic animals, which may cause the extinction of B. refastens in regions overstocked with livestock. In Sudan, the pods are said to be the most valuable forage for camels (Sanon, *et al* 2007).

**2.7-1-3:Nutritive value**:

The nutritive value of the pods is characterized by crude protein 13.5% dry matter (DM), net energy 5.4 MJ /kg of DM, digestible

protein /FU 0.19, and digestible DM (leaves) 51%. Fuel: The wood makes acceptable firewood and good charcoal. Fiber: The crude bark is used for binding. The best fiber serves as a plaiting and binding material, and in Sudan the fiber is extracted for cordage (FAO,UNEP.1983).

**2.8: *Family Rhamnaceae* :**

Trees or shrubs or very rarely herbs, leaves usually with stipules, alternate or opposite, simple, flowers usually cymose or clustered, small hermaphrodite or rarely polygamous. fruits vary in size, often drupaceous (Fadel Elseed,1999).

**2.8-1*: Ziziphus spina- Christi*:**

Local name Sidir

A shrub or small tree up to 9m high bark pale- grey, thorn in Paris, one straight and one recurved, leaves ovate- lanceolate, flower, yellow in colour, fruit fleshy (Bebawi, 1991). The tree flowers between August to December fruits between October to January. It most commonly grows by seasonal water course and near depressions ( El Amin,1990) .ornamental tree , often planted in settlements as a shade- tree , and because of its edible fruit . It yields a good fire wood and charcoal.

**2.8-1-1:Habitat and distribution:**

On short grass savanna on banks of rivers, streams valleys and water depressions on height salty soils. common on central Sudan and north Sudan a long the Nile tributaries on the drier parts of Africa especially northeast Africa (Gibreel,2008).

**2.8-1-2:Uses :**

The timber is used for tool handle, fence posts, walking sticks, furniture, bent wood. The leaves are grazed by animals. The branches lopped used to make thorn hedges and as fuel and charcoal (Gibreel, 2008)

The green leaves are much sought after by camels, and are also eaten by sheep and goats, but generally rejected by cattle perhaps because of the spines. Goats are particularly fond of the young leaves. The fruits are eaten by all animals, and are also collected and eaten by human. ( IBPGR,1984 ). Fadel Elseed (1999). Indicated that the DM, CP, CF, EE, and NFE respectively. ( 29.36 -34.17), ( 25-26 ), (14 -15 ), ( 0.76- 2.15 ) and ( 48.64 - 51. 75 ) % . That the macro elements Ca, Mg, p. ( 1.51- 1.22 ), ( 0.65 - 0.72) nd ( 0.15 - 0.20 ) % .

**2.9 : *Family Combretaceae:***

Medium – sized to large trees up to 20 m high .Leaves alternate, rarely opposite elliptic to ovate lanceolate, 2-8x 1.3 – 5 cm; densely silky becoming pubescent beneath . Inflorescence small greenish – yellow globes heads; petals absent. Fruit in globes cone – like heads, beaked by persistent receptacle (El Amin, 1990) .

**2.9-1: *Combretum aculeatum*.**

Scan dent or rumbling shrubs with lax branches, 2.5 - 4 m high young branches grey brownish, pubescent; older branches brownish white covered with recurved spines of the old petioles, 1- 1.5 cm long . Leaves alternate, pubescent on both sides , about 7x5 cm .

Inflorescence axillary racemes, flowers whitish, scented, lower receptacle about 7mm long , constricted, upper receptacle about 5x3 - 4mm, sepals deltoid , densely pubescent, petals oblanceolate, 4-6x1-2mm . Hairy, stamens 4-9 mm long, anthers orange. Fruit 5- winged, obviate, 1.5- 2.5 x1.5 -2.2 cm whitish brown. Flowers March – June, fruits July –October (ElAmin, 1990).

**2.9-1-1:Habitat and distribution:**

Widespread in the terinalia –combretum belt of central and southern Sudan in the tall grass savanna on sandy or loamy soils (Elmin,1990) .

**2.8-1-2:Uses**:

There was a decline in the feeding activities of all animal species from rainy to dry season, while resting and ruminating activities were increasing at the same time. This decline in time spent feeding was more important for cattle (from 72 to 39% of total time) as they relied on the herbaceous biomass for feeding, while sheep and goats made a shift in the feeding activities from grazing to browsing when the herbaceous biomass decreased. Goats browsed more than 20 species daily but the most preferred species were Acacia senegal, B. aegyptiaca and Pterocarpus lucens. The mean height reached by goats when browsing was higher (1.65m) than that of cattle (1.47m) and sheep (0.87m). The result from this study can be used to select species for regeneration and to advice farmers on the importance of herd composition (Sason *et al*.,2009).

Table (1): Browse Trees Investigation in the southern Darfur

| Botanical name | Local name | Family |
|---|---|---|
| ***Acacia tortilis*** | Seyal | ***Mimosaceae*** |
| ***Cadaba farinose*** | Serah | ***Capparidaceae*** |
| ***Balanites aegyptiaca*** | Hagleeg | ***Balanitaceae*** |
| ***Acacia nilotica*** | Sunt | ***Mimosaceae*** |
| ***Ziziphus spina-christi*** | Sidir | ***Rhamnaceae*** |
| ***Bauhinia rufescens*** | Kulkul | ***Caesalpiniaceae*** |
| ***Combretum aculeatum*** | Shehat | ***Combretaceae*** |

**2.10:Camels in Sudan:**

**2.10-1:Distribution:**

Distributed throughout the northern part of the country in belt north. The density population areas are Kordafan, Eastern Sudan and Darfur states

Camels depend on pasturelands to obtain their mineral requirements. But rarely forage can satisfy these requirement. (Shamat, 2009).

The camel, a multi purpose animal, is an important component of the dry and semi dry ecosystem, where it makes optimal utilization of the major vegetation and limited water resources better than any other domestic animal species. It has a unique physiological system fitted to desert environment, (Higgins, 1985).

Camels in southern Darfur are commonly raised under nomadic conditions. The annual migrations of nomads vary from year to year to exploit the seasonally abundant forage depending on the amount of rainfall (Abu Sin, 1991).

**2.10-2:Nutrition:**

In its natural habitat the camel graze on great variation of plant species. Trees and shrubs are the major dietary components for camels (Mainly browsers) although they consume herbaceous plants (Gauthier-pilters and Dagg 1981, Wilson 1984, Elmi 1989). The nutritive value also varies accordingly (Wordeh, 1981).

Camels during hot season graze early in the morning and late afternoon. When it is hot they sit down heads directed to sun. This to subject the least surface on their bodies' direct sunlight minimizing water and energy losses (Gauthier – pilters 1974)

**2.10-3:Watering:**

Source of water for camel and frequency of watering permanent surface water is represented by, lakes and springs. The temporary surface water as streams, surface pond, and valleys, which fill up during rainy season. In addition to that camel can obtain water from fresh green forage (Schwartz and Dioli, 1992).

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1Geographical characteristics of the southern Darfur

### 3.1.1: Survey background

Southern Darfur is one of the 25 states of Sudan. It is one of the three states composing the region of Darfur in western Sudan. The region is divided into three federal states. West Darfur, south Darfur and north Darfur. It has an area of 127.300km2 and estimated population of approximately 2.890.000. Nyala is the capital of the state (Elliesie, 2010).

### 3.1.2: Location of the study area

This study was carried out in southern Darfur state [Latitudes 8º and 13º North, Longitudes 22º and 28º East]. It was conducted both during the wet season (September - October, 2009) in camels' summer habitat (Masaif), and during green the season (August - September, 2009) in camels' autumn habitat (Makharif).

### 3.1.3: Climate:

The rainy season is from July till September, transforming much of the region from dust brown to verdant green. As much of the population of Darfur is agricultural, the rains are vital. In normal years, pearl millet , a mainstay crop is ready to be harvested by November. Once harvested, the dry stalks may be fed to domestic livestock. In the far northern desert, years may pass between rainfalls. In the far south, annual average rainfall is 700 mm and many trees remain green year-round (Elliesie, 2010).

**3.2: Sample collection:-**

The sample of trees and shrubs were collected from nearly Nyala City about 4km.

Seven browse trees were collected from the study area. The samples collected contain (twigs, leaves and pods in the browse) collecting, may by be executed hand plucking and clipping or were cut with a sickle during wet season in mid September. They out were cut into pieces (2 to 5 cm). Name of each of browse trees are shown in table (1).

The samples were washed dried and packed in paper bag. Each paper sack had a label showing of the plant collected botanical and local name of the sample .Table (1).

**3.3: Laboratory analyses: -**

Proximate analyses for chemical components. Dry matter .crude protein, crude fiber, ether extract, ash and nitrogen free extract were determined according to AOAC (1980).

Browse plant species minerals were determined as for phosphorous (P), calcium (Ca) and magnesium (Mg).

According to the method described by Naumann and Bossier (1976). Calcium and magnesium were determined by atomic absorption spectrophotometer determined (2380perkin Elmer) and phosphorous was determined by the spectrophotometer (sp.6.200 unican ).

**In vitro digestion experiment** :-

In vitro dry matter (DM) digestibility (IVDMD) was determined with the procedure by Tilley and Terry (1963), by incubating in athermostatically controlled circulating water bath.

**In vitro Dry matter digestibility (**IVDMD**) % =**

Sample (DM) wt-(residue (DM).blank) / samples (DM).

**3.4: Statistical analysis:--**

The statistical analysis of the chemical composition, digestibility and minerals was done using Complete Randomize Design (CRD) according to steel *et al* (1997). A least significant difference (LSD) was carried out to test significant difference between the treatment means.

Fig (1) Hegleeg

Fig (2) kukul

Fig (3) Serah

Fig (4) Seyal

Fig (5) shehat

Fig (6) Sidir

Fig (7) Sunt

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.1.Chemical composition of browse species:

### 4.1.1.Dry matter content (DM):

Table (2) shows the dry matter content of the trees while ranges from 94.36 to 95.59%. A mean of 94.79% is higher than the amount reported by Fadel Elseed (1999) as 45% DM for some trees. Dry matter of Hagleeg is the highest trees with 95.59% whereas sidir is the lowest with 94.36% DM as Shown in Appendix (1)

There were significantly ($P<0.05$) differences among the means of trees on DM.

### 4.1.2:Crude protein content (CP):

Table (2) shows that the crude protein content differed significantly ($P<0.05$) among trees the species. Hagleeg crude protein content was 16.23%, this agrees with was reported by Fadel El seed (1999).

Ziziphus spina-christi had a value of 11.37% which lies within range 11.1 to 26.40% found by Le Houerou (1980). Serih crude protein content 14.34% CP, and Kulkul crude protein content 12.80% as Shown Appendix (2).

### 4.1.3: Crude fiber content (CF):

Table (2) shows the crude fiber content of the different trees was ranging from 27.94 to 34.64%.There were significant ($P<0.05$) differences. The crude fiber content trees is similar to the findings 10.99 to 35.56% reported by Fadel Elseed (1999). However, this was higher than those findings of (Dougall, *et al* 1964). Serih has the highest crude fiberb34.64%, but Sidir was lowest crude fiber content 27.94% as shown in Appendix(3 ).

### 4.1.4: Ether Extract content (EE):

Table (2)and Appendix (4) give the EE content of the different trees. The EE content ranged from 1.90 to 3.97%. A mean of 2.7% EE is higher than That amount 0.80 to 2.3% obtained by El ginaid (1997). However, it is lower than the amounts reported by Le Houerou (1980) as 2.5-7% .Sidir had the highest EE content with 3.97%, whereas Kulkul is the lowest with 1.90% EE, was significantly ($P<0.05$) different among the means.

### 4.1.5: Ash content:

Table (2) shows total Ash content of different trees indicating significant difference ($P<0.05$).The mean value ranged from 4.49 to 8.37% . Shehat is the highest one with 8.37% Ash, Sunt is the lowest one with 4.49% Ash.Appendix (5). The results which lies within the range 3.65 to14.32% reported by Fadel Elseed (1999). Also similar results 3.10 to 9.7% were reported by El ginaid (1997).

### 4.1.6: Nitrogn free extract content (NFE):

Table (2) indicates a significant difference in NFE content, ranging from 36.75 to 46.26%. A mean of 42.15% is lower than the amount reported by Fadel Elseed (1999) as 63.79 Also That is lower than those obtained by Dougall *et al* .(1964).

Sunt has the highest NFE 46.26%, but serih is the lowest NFE content 36.75% .Appendix (6).

Table (2): The Chemical Composition of some browse species in Southern Darfur (Nyala).

| *Botanical name (local name)* | DM | CP | CF | EE | Ash | NFE |
|---|---|---|---|---|---|---|
| *Acacia tortilis* ( Seyal) | $94.45^{bc}$ | $12.74^{c}$ | $29.94^{e}$ | $2.77^{c}$ | $6.08^{c}$ | $42.93^{cd}$ |
| *Cadaba farinose* (Serah) | $95.02^{ab}$ | $14.34^{b}$ | $34.64^{a}$ | $1.94^{e}$ | $7.30^{b}$ | $36.75^{e}$ |
| *Balanites aegyptica* (Hagleeg) | $95.59^{a}$ | $16.23^{a}$ | $34.17^{b}$ | $2.81^{c}$ | $4.51^{e}$ | $37.88^{e}$ |
| *Acacia nilotica* (Sunt) | $94.95^{bc}$ | $11.55^{cd}$ | $30.15^{c}$ | $2.50^{d}$ | $4.49^{e}$ | $46.26^{a}$ |
| *Ziziphus spina-christi* (Sidir) | $94.36^{c}$ | $11.37^{d}$ | $27.94^{g}$ | $3.97^{a}$ | $5.91^{cd}$ | $45.19^{ab}$ |
| *Buhinia rfesces* (Kulkul) | $94.49^{bc}$ | $12.80^{c}$ | $29.99^{d}$ | $1.90^{e}$ | $5.76^{d}$ | $43.95^{bc}$ |
| *Combretum aculeatum* (Shehat) | $94.68^{bc}$ | $11.77^{cd}$ | $29.49^{f}$ | $3.04^{b}$ | $8.37^{a}$ | $42.09^{d}$ |
| **S.E** | 0.1779 | 0.4478 | 0.0143 | 0.0143 | 0.0608 | 0.4165 |

DM: Dry Matter CP: Crude protein CF: Crude fiber
EE: Ether Extract NFE: Nitrogen

*Means within the same columns with different superscripts are significantly different at ($P<0.05$).

**4-2-Minerals content of trees:**

**4-2-1-Calcium content (Ca):**

Table (3) and Appendix (7). Show the mineral content of the seven trees with Ca content ranged from 0.75 to 2.06%.With highest level lies with range 0.11 to 4.90% as reported by Fadel Elseed (1999), this is similar to results 0.4 to 2.8% obtained by El ginaid (1997).

For comparison Sunt is the highest 2.06% Ca, Seyal is lowest 0.75%. There are significant ($P<0.05$) difference among the means. For Calcium content.

**4-2-2-Phosphorus content (P):**

Table (3) shows the phosphorus content of trees there are difference, among the means. It was found that means value of phosphorus content, ranged from 0.051 to 0.50%P.Shown Appendix (8)

Serih is the highest with 0.50%P, Hagleeg is lowest with o.o51% P. The result higher than values 0.02- 0.25% reported by El ginaid (1997).

**4-2-3-Magnesium content (Mg):**

Magnesium content of the trees is given in table (3).The mean value is within the range 0.19-0.4 %.

All the trees had low magnesium content than that reported by Fadel Elseed (1999). Hagleeg had the highest content Mg; Seyal had the lowest Magnesium content. As shown Appendix (9).

Table (3): Macro mineral content mg/k some Browse species in South Darfur

| *Botanical name(local name)* | | *Ca* | *P* | Mg |
|---|---|---|---|---|
| *Acacia tortilis* | (Seyal) | $0.747^{e}$ | $0.060^{a}$ | $0.187^{c}$ |
| *Cadaba farinose* | (Serah) | $1.60^{b}$ | $0.050^{b}$ | $0.400^{a}$ |
| *Balanites aegyptica* | (Hagleeg) | $1.057^{d}$ | $0.050^{b}$ | $0.460^{a}$ |
| *Acacia nilotica* | (Sunt) | $2.06^{a}$ | $0.053^{b}$ | $0.29^{b}$ |
| *Ziziphus spina-christi* | (Sidir) | $1.047^{d}$ | $0.060^{a}$ | $0.27^{b}$ |
| *Buhinia rufescens* | (colcol) | $1.35^{c}$ | $0.060^{a}$ | $0.400^{a}$ |
| *Combretum aculeatum* | (Shehat) | $1.16^{d}$ | $0.060^{a}$ | $0.317^{b}$ |
| **S.E** | | 0.0735 | 0.0007 | 0.0320 |

Ca: Calcium P: Phosphors Mg: Magnesium

*Means within the same columns with different superscripts are significantly different ($P<0.05$)

**In Vitro Dry Matter Digestibility (IVDMD):**

Table (4) shows that the in vitro dry matter digestibility of different trees ranging from 47.55 to 64.77% IVDMD ,indicating significant ($P<0.05$) difference among the species. Sunt had the highest 64.77%, Sidir is lowest 47.55% IVDMD. Appendix (10).

Table (4): In vitro Dry matter Digestibility (%) of Browse Species. In Southern Darfur

| *Botanical name* | *(Local name)* | *mean* |
|---|---|---|
| *Acacia nilotica* | (Sunt) | 64.77[a] |
| *Balanites aegyptica* | (Hagleeg) | 63.88[a] |
| *Combretum aculeatum* | (Shehat) | 55.60[b] |
| *Cadaba farinose* | (Serah) | 54.94[bc] |
| *Acacia tortilis* | (Seyal) | 52.81[bc] |
| *Bauhinia refescens* | (Kulkul ) | 51.56[c] |
| *Ziziphus spina-christi* | (Sidir) | 47.55[d] |
| E.S | | 1.6491 |

*Means within the same columns with different superscripts are significantly different (P<0.o5).

# Conclusion and Recommendation

It was concluded from the study of the in vitro digestibility of seven trees branch desired by camels that trees contribute greatly to the nutrition of camels in Southern Darfur

Therefore we recommended that more research needed to be carried on the trees and shrubs in Southern Darfur for animal nutrition.

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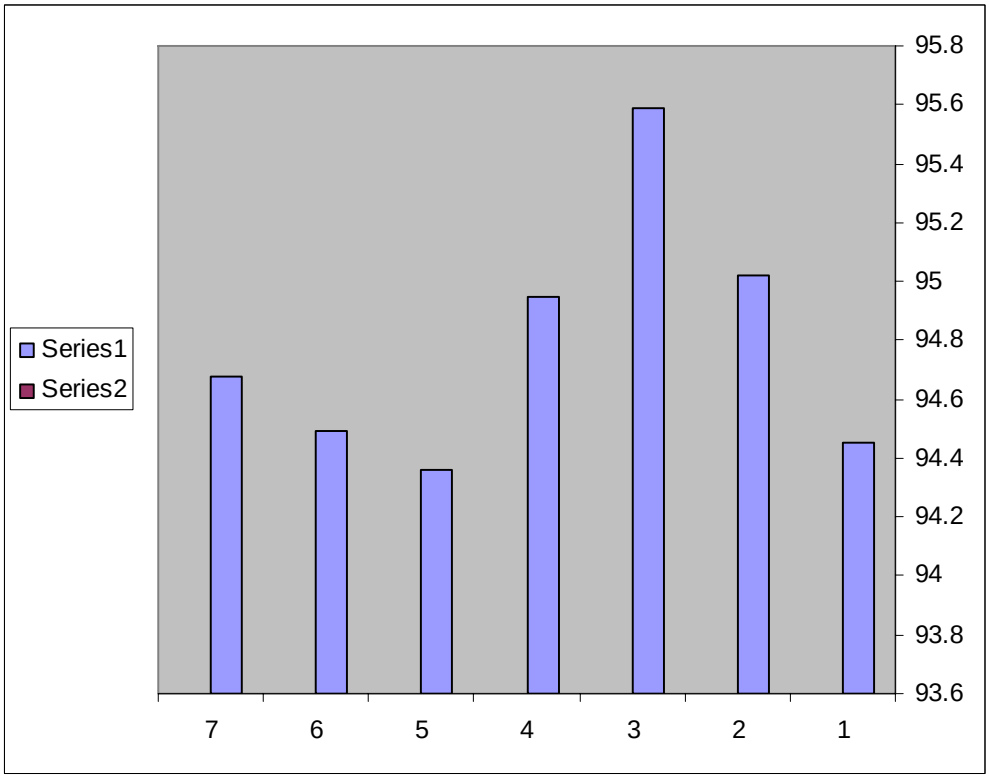
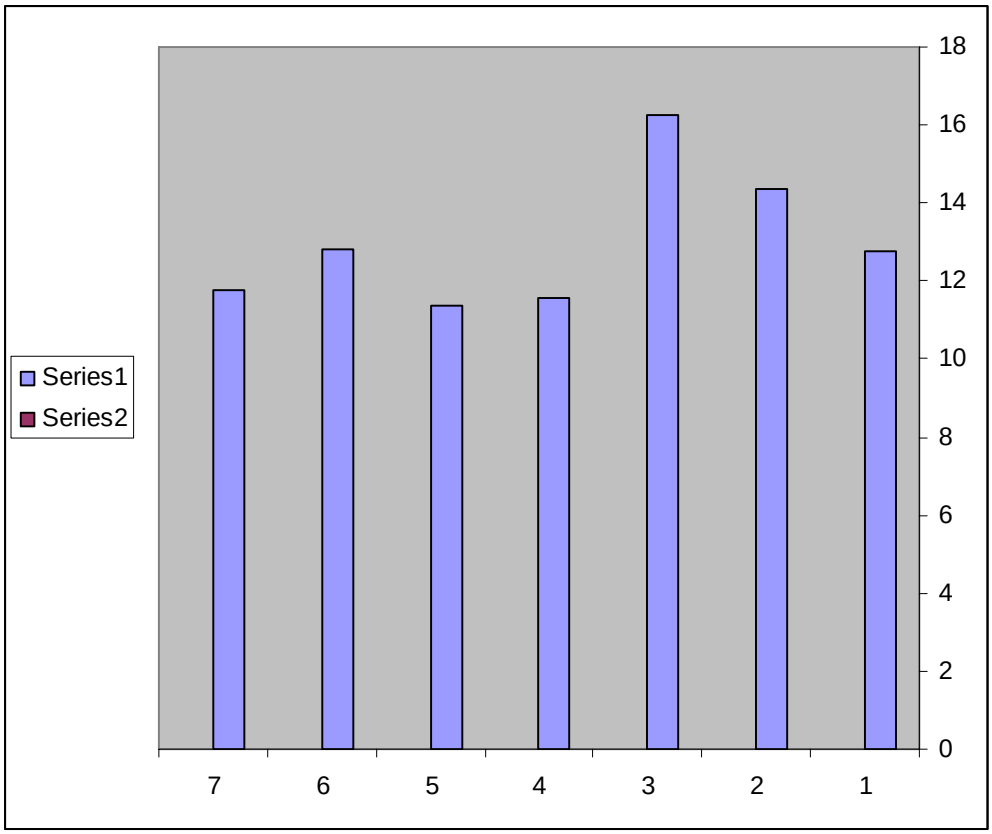
Appendix:(1)




Dry Matter content of different trees
Chemical Analysis

1- Acacia tortilis (seyal)
2-Cadaba farinose (Serah)
3- Balanites aegyptiaca (Hagleeg)
4-Acacia nilotica (Sunt)
5-Zizphus spina-christi (Sidir)
5- Buhinia rufescens(Kulkul)
7- Combretum aculeatum (Shehat)

Appendix:(2)

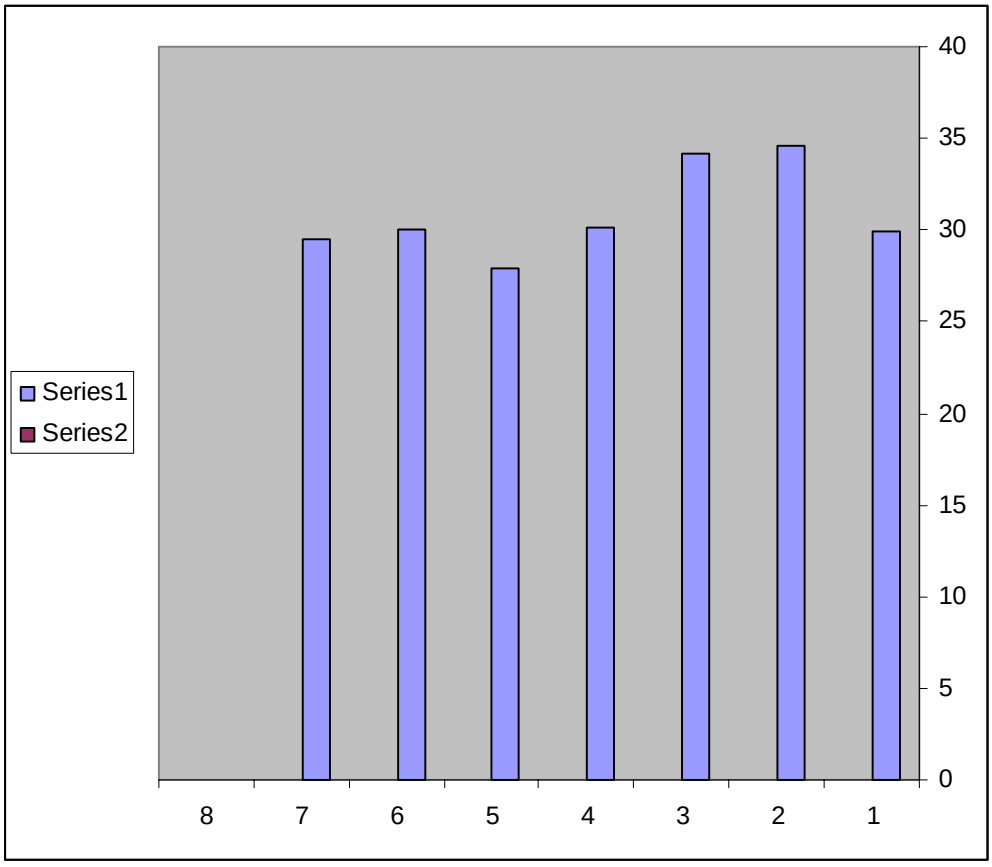



Crude protein (CP) content of different trees

Chemical Analysis

1- Acacia tortilis (Seyal)
2- Cadaba farinose (Serah)
3- Balanites aegyptiaca (Hagleeg)
4- Acacia nilotica (Sunt)
5- Zizphus spina-christi (Sidir)
6- Buhinia rufescens (Kulkul)
7- Combretum aculeatm (Shehat)

Appendix(3)

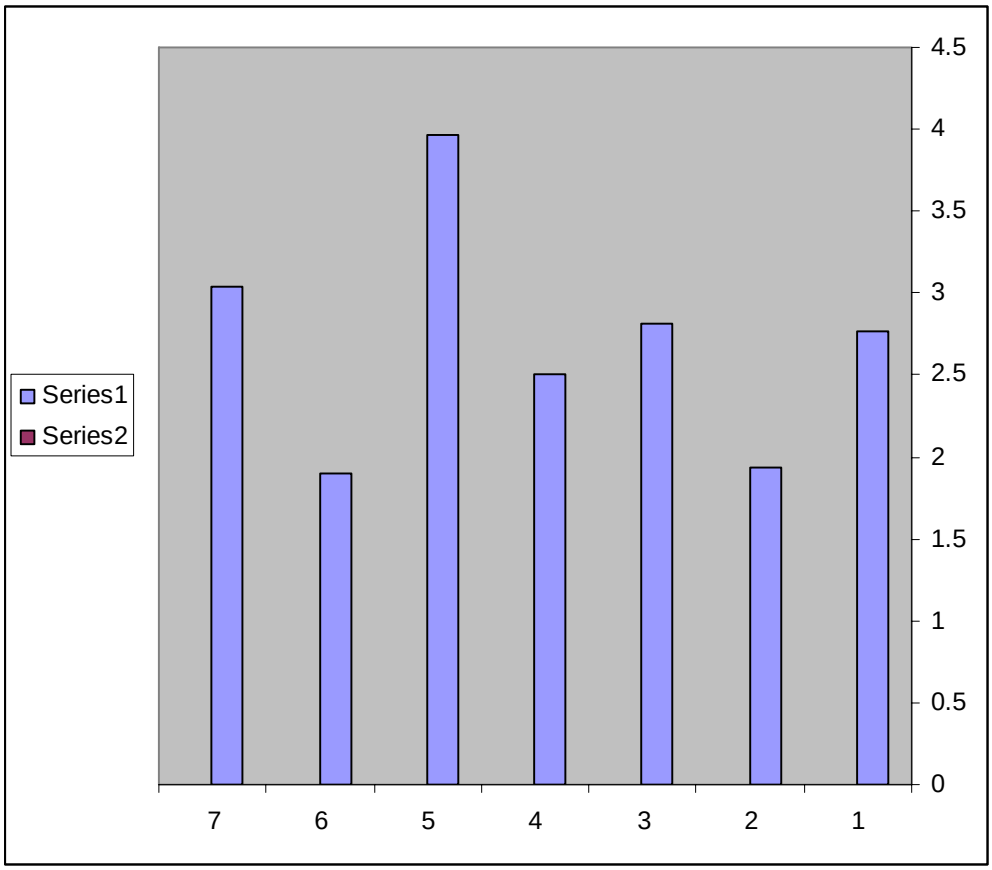



Crude Fiber (CF) content of different trees

Chemical Analysis

1- Acacia tortilis (Seyal)
2- Cadaba farinose (Serah)
3- Balanites aegyptiaca (Hagleeg)
4- Acacia nilotica (Sunt)
5- Zizphus spina-christi (Sidir)
6- Buhinia rufescens (Kulkul)
7- Combretum aculeatm (Shehat)

Appendix(4)

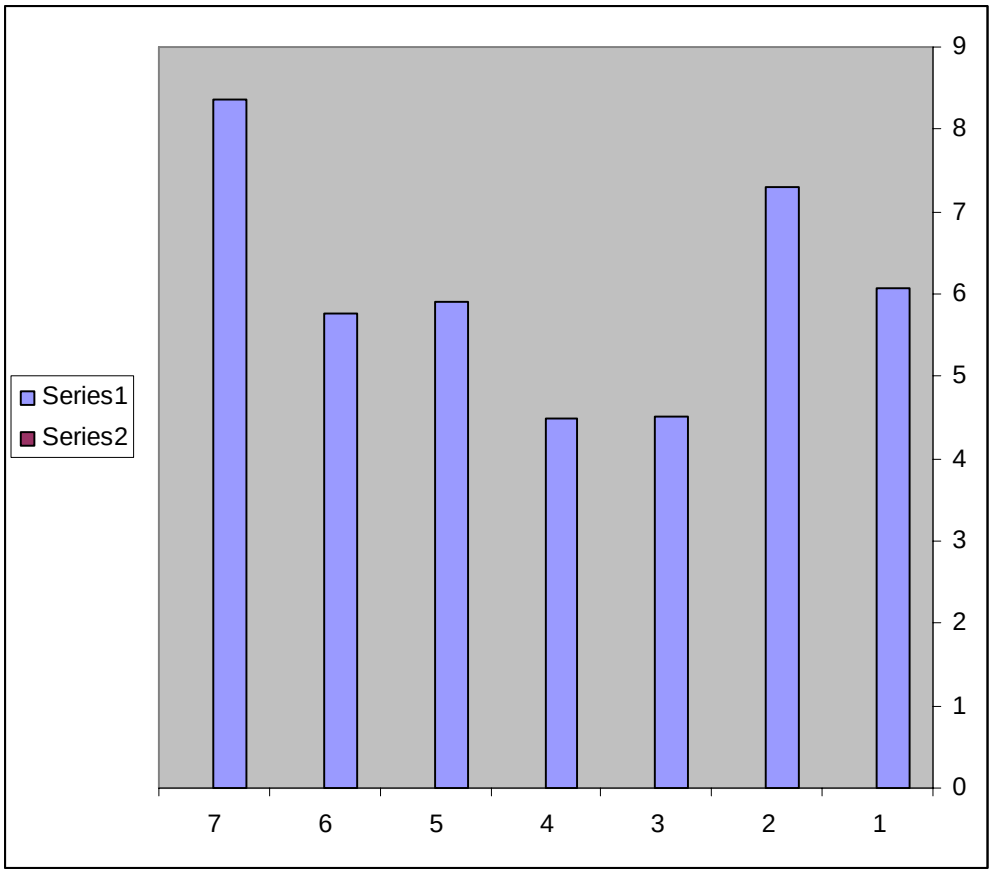



Ether Extract(EE) content of different trees

Chemical Analysis

1- Acacia tortilis (Seyal)
2- Cadaba farinose (Serah)
3- Balanites aegyptiaca (Hagleeg)
4- Acacia nilotica (Sunt)
5- Zizphus spina-christi (Sidir)
6- Buhinia rufescens (Kulkul)
7- Combretum aculeatm (Shehat)

Appendix(5)

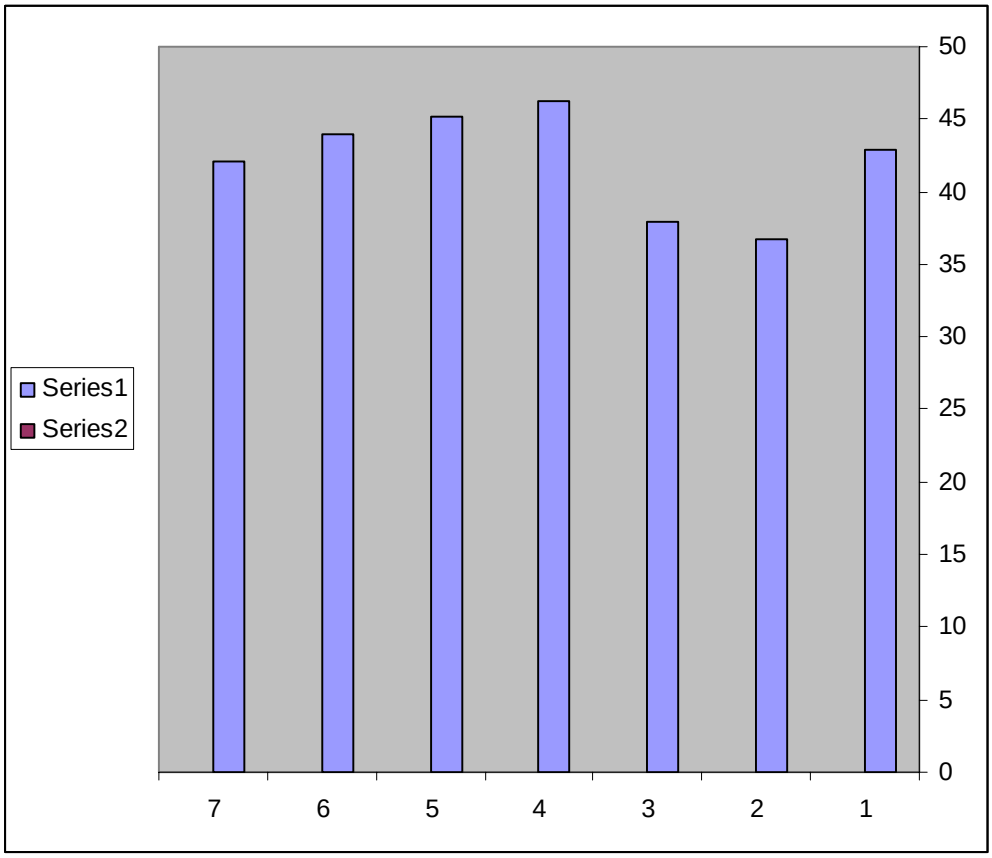



Ash content of different trees

Chemical Analysis

1- Acacia tortilis (Seyal)
2- Cadaba farinose (Serah)
3- Balanites aegyptiaca (Hagleeg)
4- Acacia nilotica (Sunt)
5- Zizphus spina-christi (Sidir)
6- Buhinia rufescens (Kulkul)
7- Combretum aculeatm (Shehat)

Appendix(6)

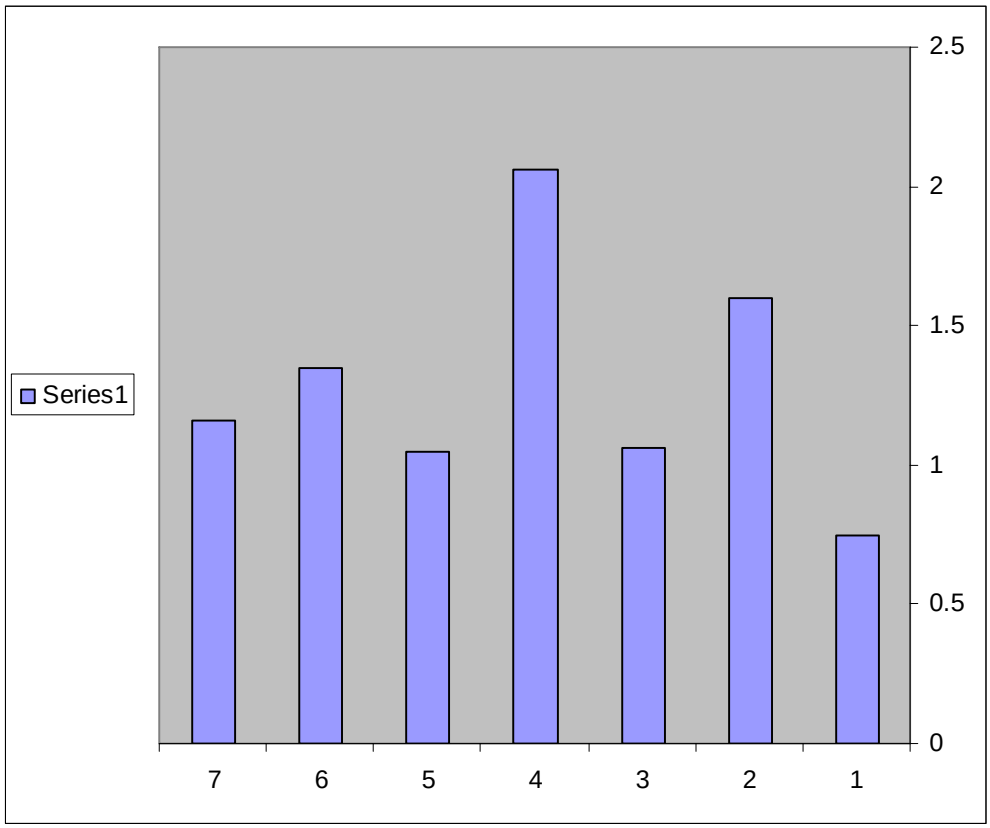



Nitrogen free Extract content of different trees

Chemical Analysis

1- Acacia tortilis (Seyal)
2- Cadaba farinose (Serah)
3- Balanites aegyptiaca (Hagleeg)
4- Acacia nilotica (Sunt)
5- Zizphus spina-christi (Sidir)
6- Buhinia rufescens (Kulkul)
7- Combretum aculeatm (Shehat)

Appendix(7)

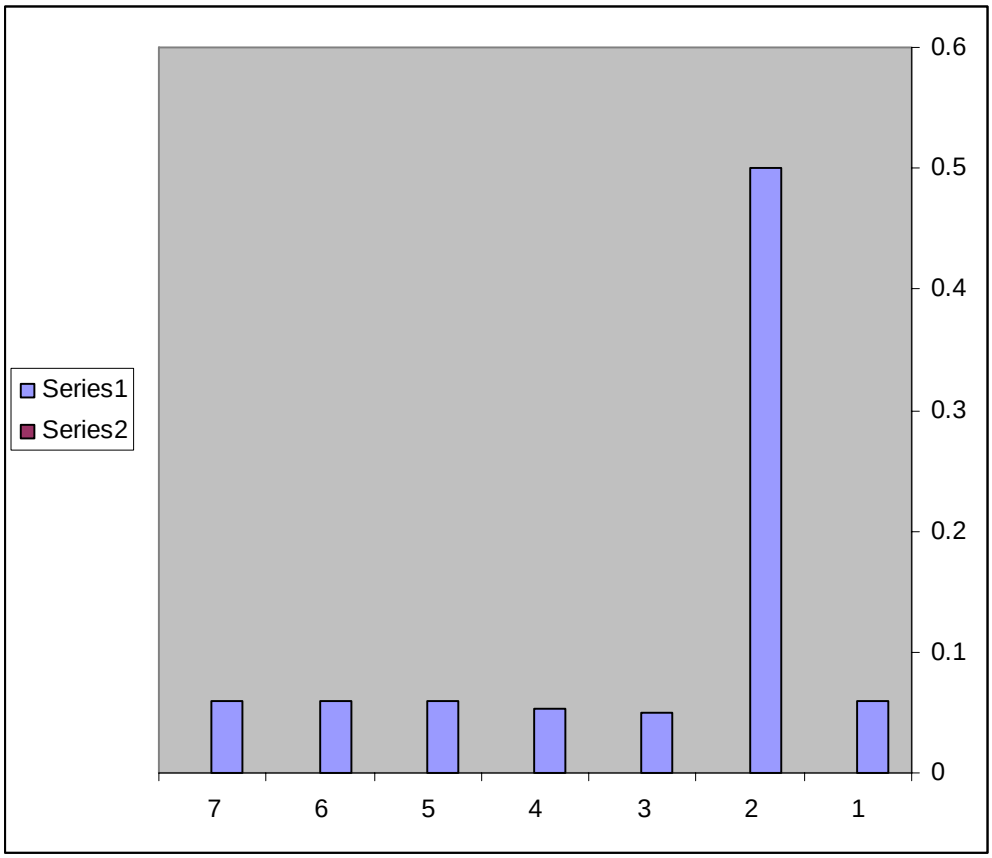



Calcium content of different trees

Chemical Analysis

1- Acacia tortilis (Seyal)
2- Cadaba farinose (Serah)
3- Balanites aegyptiaca (Hagleeg)
4- Acacia nilotica (Sunt)
5- Zizphus spina-christi (Sidir)
6- Buhinia rufescens (Kulkul)
7- Combretum aculeatm (Shehat)

Appendix(8)

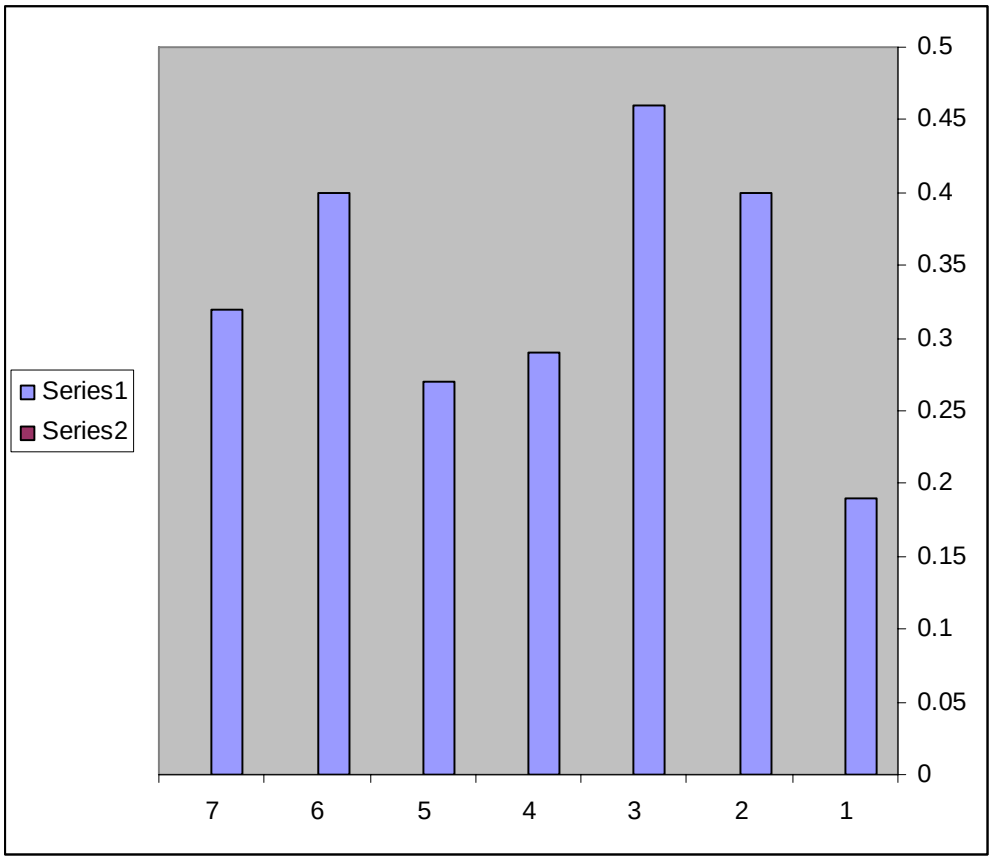



Phosphorus content of different trees

Chemical Analysis

1- Acacia tortilis (Seyal)
2- Cadaba farinose (Serah)
3- Balanites aegyptiaca (Hagleeg)
4- Acacia nilotica (Sunt)
5- Zizphus spina-christi (Sidir)
6- Buhinia rufescens (Kulkul)
7- Combretum aculeatm (Shehat)

Appendix(9)

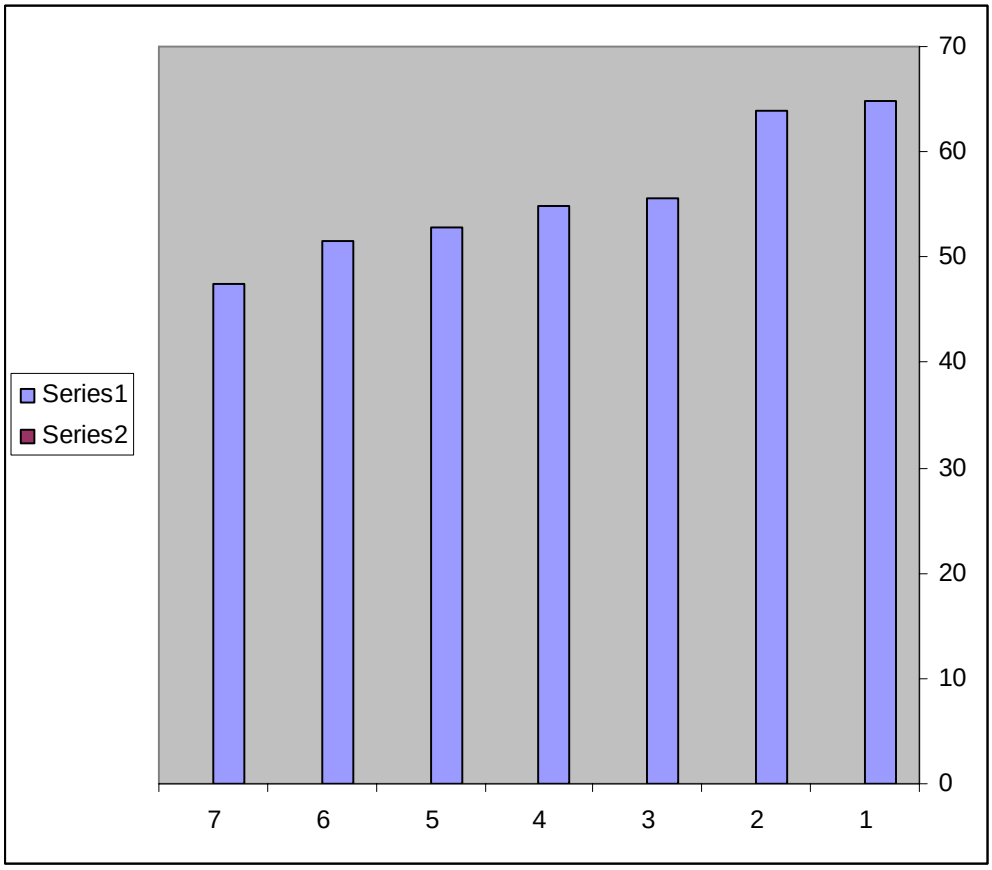



Magnesium content of different trees

Chemical Analysis

1- Acacia tortilis (Seyal)
2- Cadaba farinose (Serah)
3- Balanites aegyptiaca (Hagleeg)
4- Acacia nilotica (Sunt)
5- Zizphus spina-christi (Sidir)
6- Buhinia rufescens (Kulkul)
7- Combretum aculeatm (Shehat)

Appendix(10)




In vitro dry matter digestibility content different trees

1-Acacia nilotica (Sunt)
2- Balanites aegyptiaca(Hagleeg)
3-Combretum aculeatum(Sunt)
4- Cadaba farinose (Serah)
5-Acacia tortilis (Seyal)
6- Bauhinia refescens (Kulkul)
7-Ziziphus spina-christi (Sidir)